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Commentary on JTCVS-17-984R4 Evaluating outcomes after cardiac surgery: a complex challenge requiring flexibility.

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Please submit your article's Central Message here. The text box will limit you to 200 characters, spaces included	Quality of life and quality of recovery are emerging measures of outcome in cardiac surgery. Longitudinal analysis and linear mixed models are precious tools to incorporate into statistical analysis.
Please submit the abbreviated legend for your Central Picture. The text box will limit you to 90 characters, spaces included	Filippo Rapetto and Vito D. Bruno

Evaluating outcomes after cardiac surgery: a complex challenge requiring flexibility.

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Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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In the present issue of the *Journal*, Diab and colleagues present their institutional outcomes for cardiac surgery patients according to different Intensive Care Unit length of stay. In a prospective single centre cohort study, the Authors focused their analysis on longitudinal assessment of patient's quality of life and quality of recovery.

The article inspires some comments about the current era of cardiac surgery and its future directions; more specifically, it raises questions about the way the cardiac surgery community reports its results and, ultimately, assesses itself.

Historically we have been trained to report our outcomes mainly in terms of survival and early postoperative complications rates. Considering the consistent and significant decrease in mortality and morbidity, it is becoming more and more evident that a wider perspective needs to be embraced[1,2]. Reporting that our patients survive to the operations is not enough anymore; we need to demonstrate how they survive and what their quality of life looks like as the time goes by. It is also important to highlight that although it is sometimes useful and certainly appealing to conceptualize health as a dichotomous and absolute entity, it is clear that the actual scenario is far more complex: time-dependence and clustering are frequently involved in modern analysis. Moreover, health markers do not change suddenly and irreversibly, but vary over time in different directions and the variables of interest are not always measured at the same time intervals for each individual.

Quality of life and quality of recovery perfectly exemplify our statements: they are useful variables for analysing clinical outcomes, and there is growing evidence demonstrating their validity and reproducibility in cardiac surgery; they are non-dichotomous variables that can be tested multiple times for each subject and can improve or worsen at every timepoint.

Unfortunately, although these are surely simple concepts from a theoretical point of view, introducing such variables into statistical models adds significant complexity to the analysis.

In their paper, Diab and colleagues used the PostopQRS™ tool to measure patient's quality of recovery at seven different moments, from the preoperative period to twelve months postoperatively. The aim of their analysis was to detect differences in quality of recovery over the study period in two groups of patients defined by different Intensive Care Unit length of stay. In order to conduct the study, the Authors needed a model capable of incorporating different levels of information, namely accounting for variability between groups while adjusting for longitudinal variability caused by multiple repeated measurements[3]. In such a scenario, flexibility of the model is the key. Linear mixed model allowed to highlight not only a different overall recovery at twelve months between the two groups, but more importantly a different pattern of recovery over time even when similar values were found at the end of the study.

In terms of clinical outcomes, the Authors have supported their analysis using propensity score (PS) matching; the presence of differences in preoperative characteristics could have had an impact on the clinical outcomes, but the Authors avoided this risk by using PS matching thus eliminating any further doubts on their results. We have been aware of the benefits of PS matching for a very long time[4] and it is not the aim of this paper to renew these concepts, but it is important to highlight the flexible statistical thinking behind this study and the benefits derived from it.

This article well exemplifies how current perspectives in cardiac surgery demand more complex statistical analysis to move on from traditional modelling strategies. A flexible and effective statistical strategy is essential when reporting our long-term results and will become even more important in the future of cardiac surgery clinical research.

Central message

Quality of life and quality of recovery are emerging measures of outcome in cardiac surgery. Longitudinal analysis and linear mixed models are precious tools to incorporate into statistical analysis.

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